



**WePass2** |

FACILITATING FISH MIGRATION  
AND CONSERVATION AT THE IRON GATES



International Commission  
for the Protection  
of the Danube River



INCCDD TULCEA



JAROSLAV ČERNÍ  
WATER INSTITUTE



Julia Gatzweiler  
Edith Hödl  
Marq Redeker

# WePass2

## Update on the WePass2 project – moving from options to the preliminary design



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"From Iron Gate to Gabčíkovo Water  
Structure"  
Transfer of knowledge on fish migration  
16 May 2024



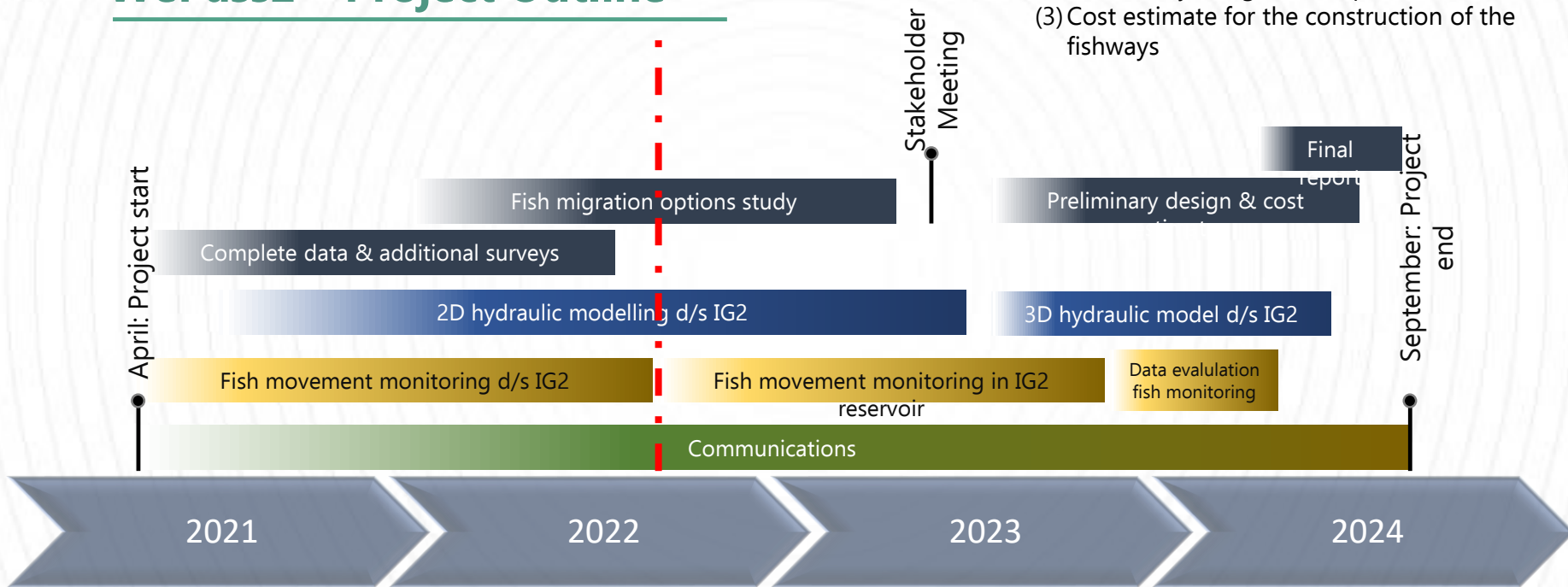
# WePass2

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## WePass2 – Project Outline

### Objectives:

- (1) Investigation of options to establish up- and downstream fish migration at both Iron Gate Dams
- (2) Preliminary design of fish pass(es)
- (3) Cost estimate for the construction of the fishways



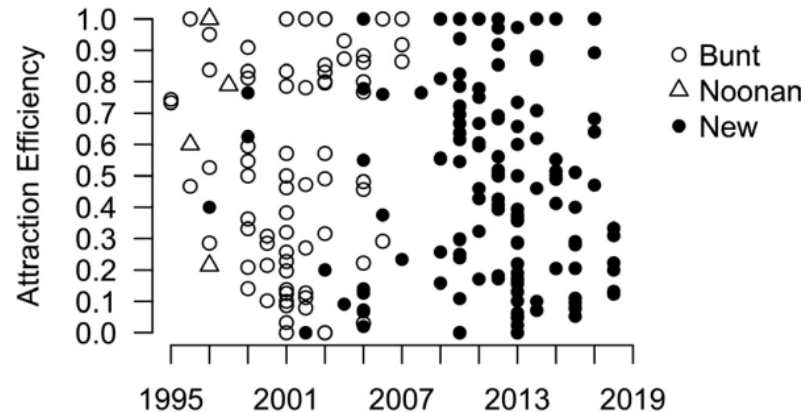
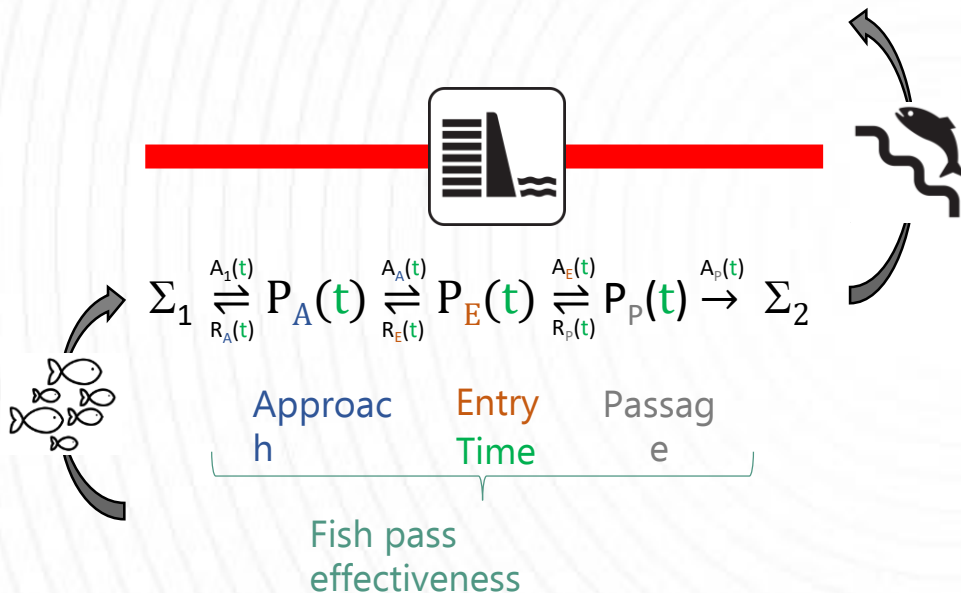
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## U/s Passage Options Study Goals



Scatterplot showing the variation of fish pass attraction (approach & entry) efficiency estimates in meta-analysis of different authors  
(Fig. in Hershey, 2021)



## U/s Passage Options Study Goals

Iron Gate 2  
Main Dam and HPP  
Serbian Secondary HPP &  
SRB ship lock

?

How many fish  
passes are  
required

?

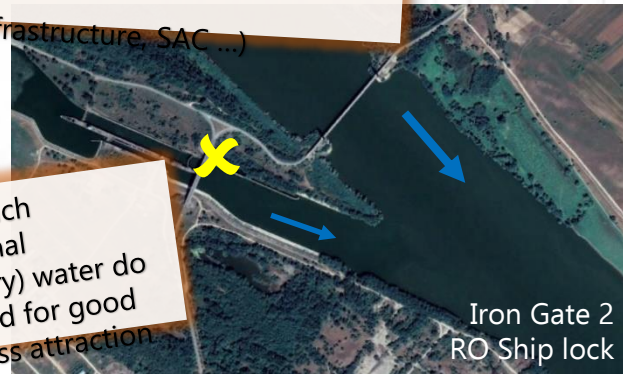
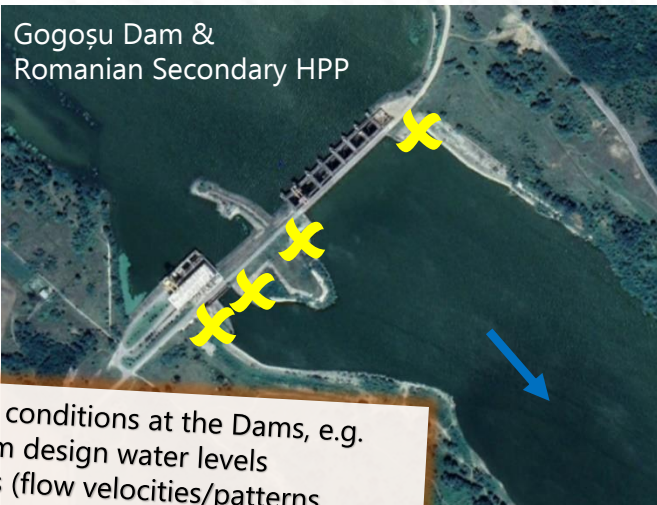
What are the specific conditions at the Dams, e.g.  
- up- and downstream design water levels  
- hydraulic conditions (flow velocities/patterns,  
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- spatial restrictions (infrastructure, SAC ...)

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How many fish  
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How much  
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Iron Gate 2  
RO Ship lock

Aerials: GoogleEarth



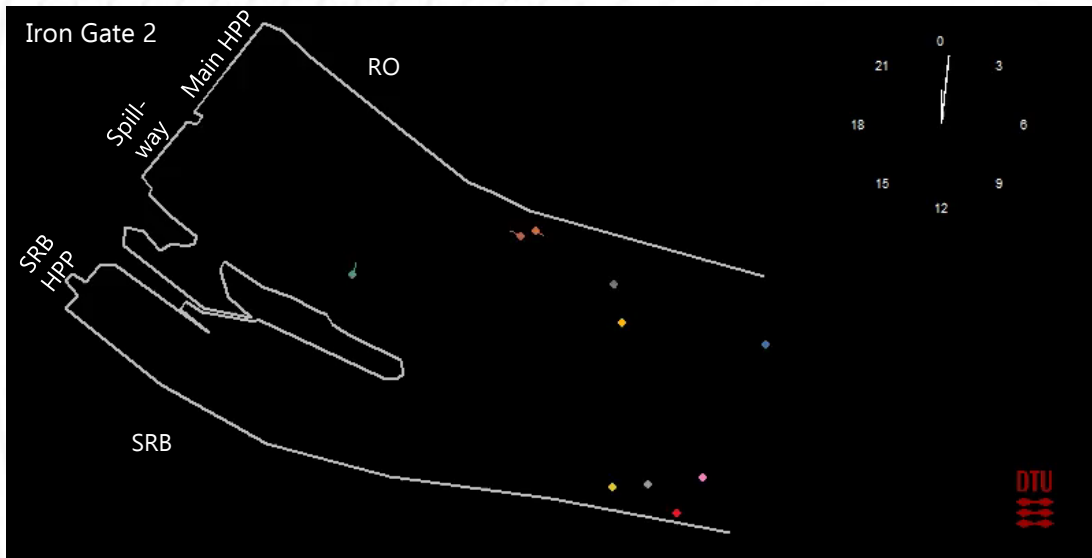
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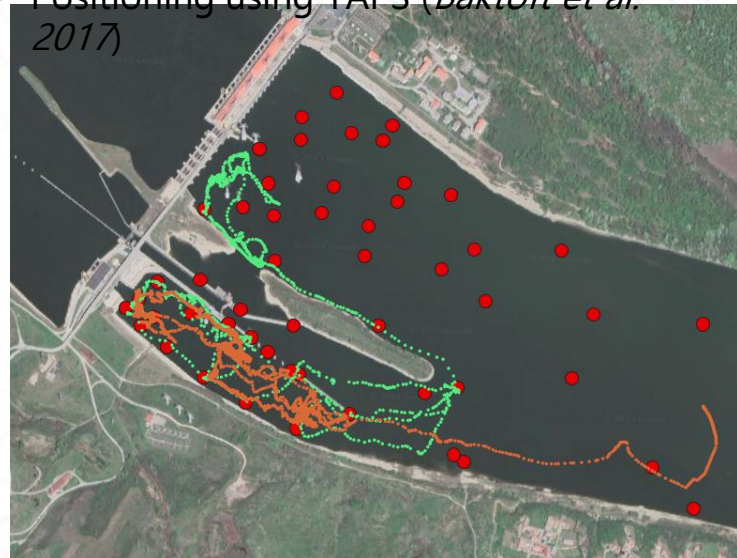


## 3D Fish Telemetry d/s of Iron Gate 2



Movement traces of 10 Vimba bream (*Vimba vimba*) in the receiver array during a 12-hour period (autumn 2021)

- October 2021 - August 2022
- 139 fishes of 5 migratory species (Barbel, Nase, Asp, Sterlet and Vimba bream)
- Positioning using YAPS (*Baktoft et al. 2017*)



Movement traces of a Sterlet (orange) and a Vimba bream (green). Red dots: Positions of the hydrophones. (Aerial: Google Earth)





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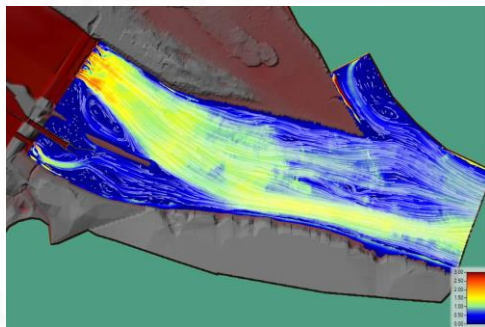
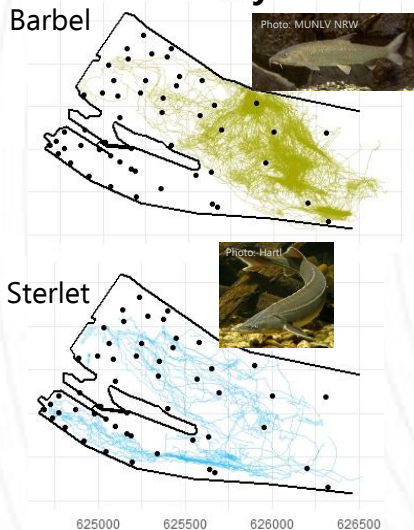
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## Fish Aggregation „Heat Maps“

Fish  
telemetry

+

2D hydraulic  
model

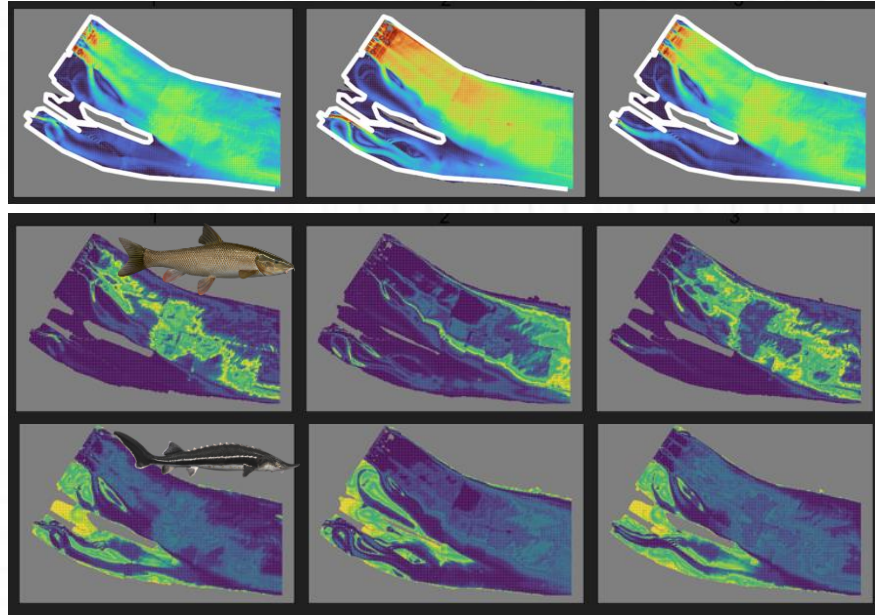


Analysis of flow velocity preferences  
of individual fish species  
with actual hourly turbine flows

Scenario 1

Scenario 5

Scenario 10



Aggregation probabilities of 2 species in 3 flow scenarios based  
on the analyzed flow velocity preferences::

yellow: very likely

green: probable

blue: never detected

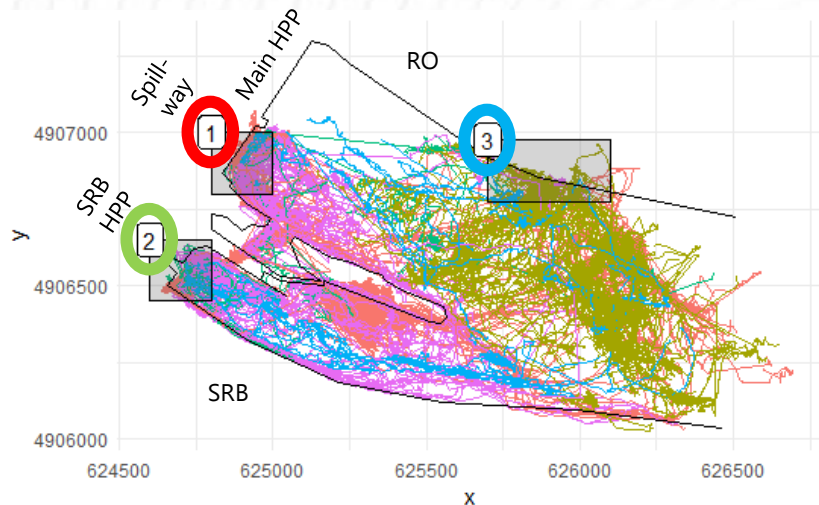


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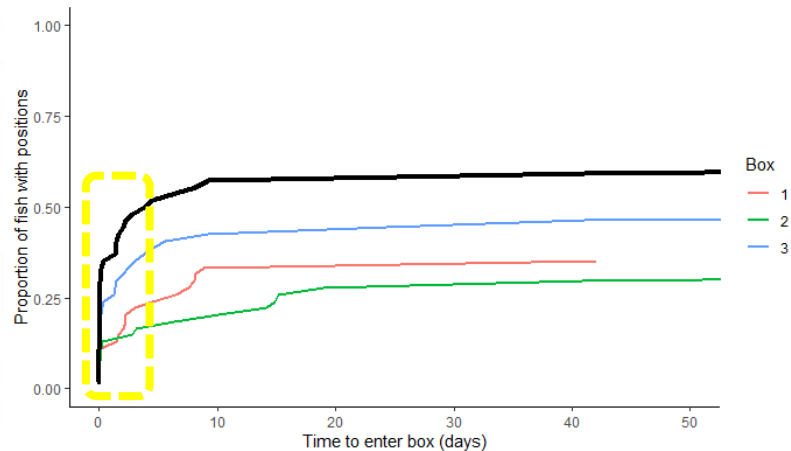


## Suggested Fish Pass Locations/Entrances d/s of IG2



(species)

asp  
barbel  
nase  
sterlet  
vimba



**3 areas**  
downstream of  
Iron Gate 2 main  
Dam



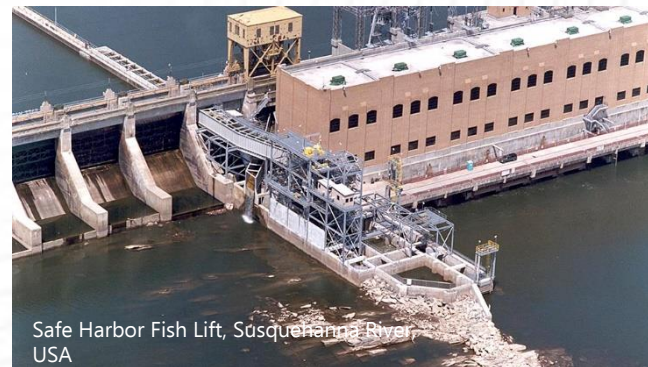


## Upstream Fish Passage Options Study

Type of fish pass	Iron Gate 1	Iron Gate 2/ Gogoşu
Non-volitional fishway (fish lift and fish lock)	✓	✓
Pool-type fish pass	✗	✓
Nature-like bypass channel	✗	✓ (in middle and upper reaches of fish pass)
Trap & truck / trap & barge	✓	✓

### ➤ 27 options (i.e. alternatives) & variants:

- Permanent structures: e.g. pool-type & nature-like fish passes,  
fish locks & fish lifts
- Operational: e.g. changes to ship lock operation
- Interim solutions: e.g. trap & barge







## Fish Pass Options Study - Outcomes

- Up- and downstream fish passage facilities/ enhancement measures are feasible
  - ⇒ Up- and downstream passage restoration/facilitation require separate facilities/measures
  - ⇒ Dam & site-specific solutions, e.g. types of fish passes
  - ⇒ Upstream fish passes: Multiple passes and entrances at each dam

- Preferred Solutions:

- Upstream passage:

- Permanent: Iron Gate 1: 2 Fish Lifts  
Iron Gate 2: 1 Hybrid Fish Pass, 1 Vertical Slot Pass and 1 Fish Lift  
Gogoşu: 1 Vertical Slot Pass
- Short-term/ interim: Trap & barge (could also be used to trial entrance locations of pool-type fish passes)



- Downstream passage:

- Turbine management plus safe alternative passage (e.g. via spillways and bypasses) to increase turbine survival



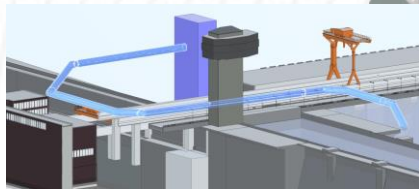


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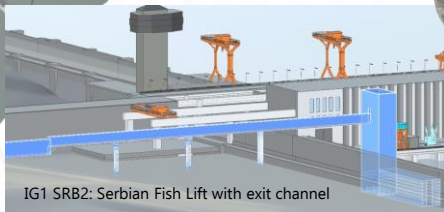
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## Preferred U/s Passage Options IG 1&2

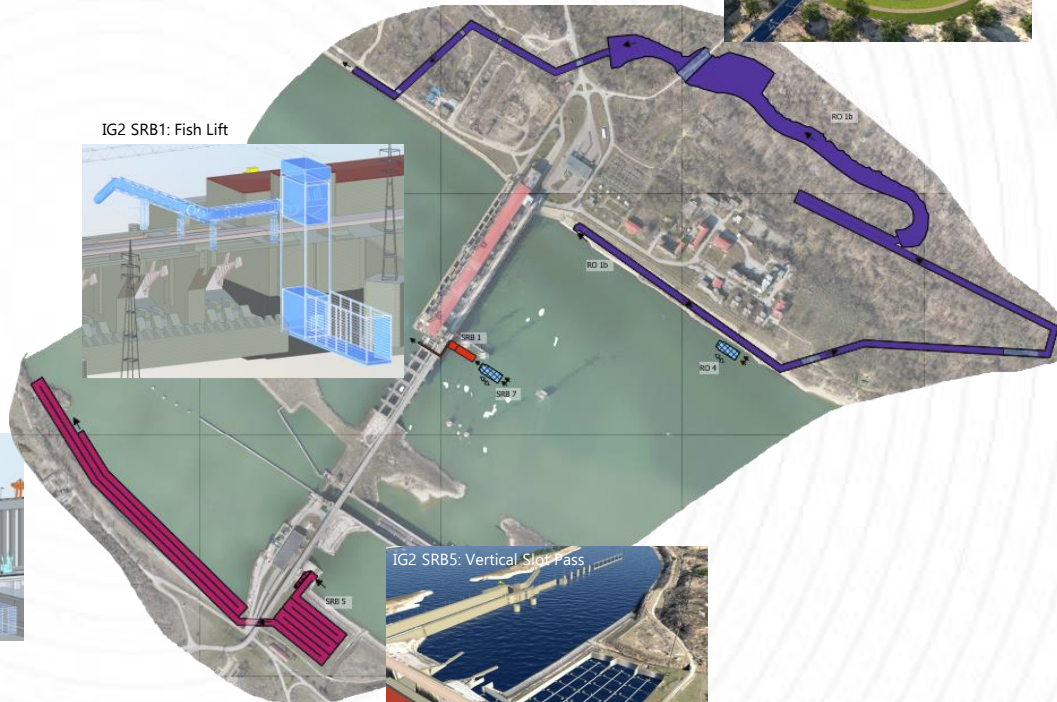
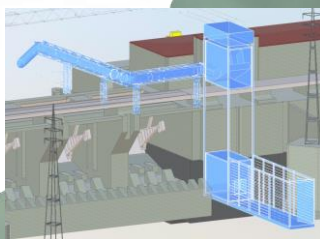
IG1 RO1b: Romanian Fish Lift with flush channel



IG1 SRB2: Serbian Fish Lift with exit channel



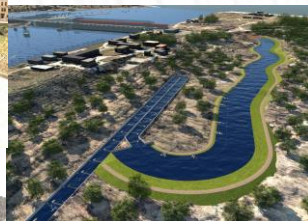
IG2 SRB1: Fish Lift



IG2 SRB5: Vertical Slot Pass



IG2 RO1b:  
Hybrid Fish Pass



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## Preferred D/s Passage Options



- **Turbine management (IG 1&2)**

Concentrate Danube flow on fewer turbines that run at (near) maximum flow ( $Q_T/Q_D = 90-100\%$ ), i.e., with wicket gates and turbine blades wide open. Operation at least during downstream migration period (May - August); ideally the whole year round



- **Safe bypass route (IG 1&2)**

IG1: Spillway bypass system (surface & bottom)  
IG2: Spillway operation



- **Fish-friendly turbines (IG 2 SRB)**



- **Guidance (IG 2 main HPP)**

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How many fish  
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Gogoşu Dam &  
Romanian Secondary HPP

Iron Gate 2  
RO Ship lock



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Aerials: GoogleEarth





## Open issues

Iron Gate 2  
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Serbian Secondary HPP &  
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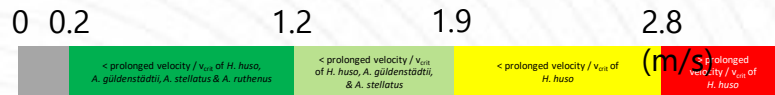
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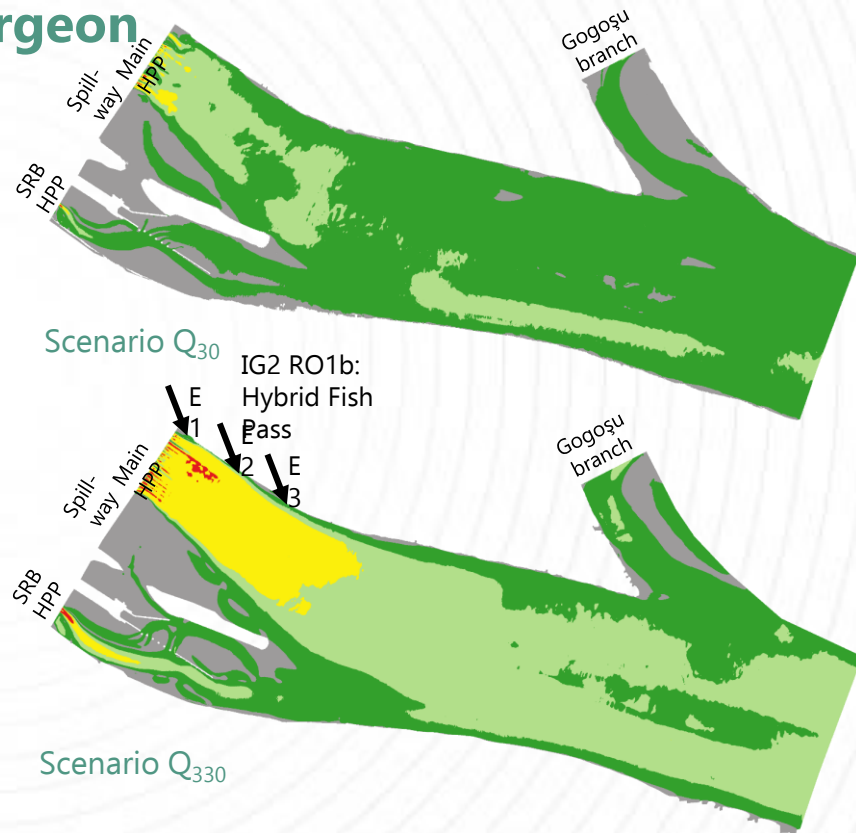


## Ethohydraulic Assessment for Sturgeon

Species	Min. length of adult migrants	U/s migration period
<i>H. huso</i>	2.15 m	Feb. - Mar.
<i>A. guldentstädtii</i>	1.1 m	Mar. - mid Apr.
<i>A. stellatus</i>	1.0 m	Mar. - May
<i>A. ruthenus</i>	0.4 m	Mar. - May

⇒ Based on

- Water temperature analysis
- Sturgeon swimming speed literature study
- Swimming performance models
- Expert judgement

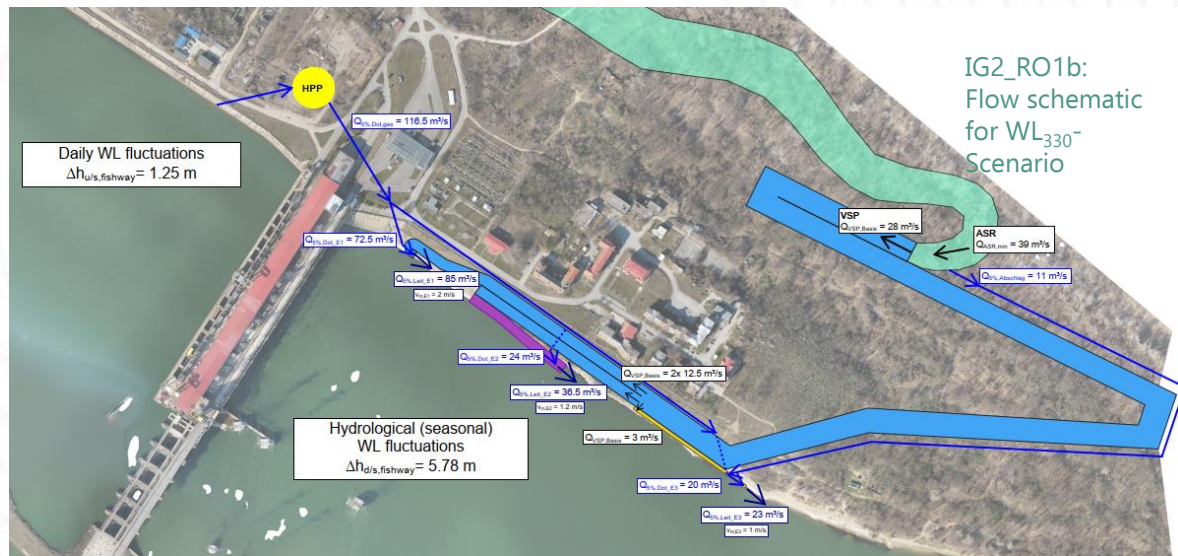
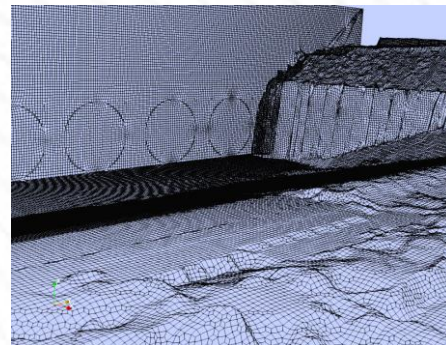




## Preliminary Design incl. 3D CFD

- Define fish pass configurations incl. technical elements
- Hydraulic calculations
- Design 3 fish passes incl. 3D hydraulic modelling of one fish pass
- Develop drawings: layouts/plans, cross & long sections and schematics of facility components
- Estimate costs
- Assess generation loss of Hydropower Plants

3D CFD model:  
Mesh viewed  
towards turbine  
outlets  
on left bank







## Estimate of Iron Gate HPP Generation Loss (based on Options Study)

Setting #1 (Auxiliary flow of certain options <u>is used</u> for power generation at Iron Gate 2)	IG Scheme generation loss (MWh/a)	IG Scheme generation loss (% of annual generation)
Preferred downstream passage facilities	314,324	1.8%
Preferred upstream passage facilities	369,440	2.1%
<b>Total</b>	<b>683,764</b>	<b>3.9%</b>

- HPP generation loss increases with number of fish pass entrances and attraction flow volume

Setting #2 (Auxiliary flow of certain options <u>is not used</u> for power generation at Iron Gate 2)	IG Scheme generation loss (MWh/a)	IG Scheme generation loss (% of annual generation)
Preferred downstream passage facilities	314,324	1.8%
Preferred upstream passage facilities	470,613	2.7%
<b>Total</b>	<b>784,937</b>	<b>4.5%</b>







## A Look over the Rim of the Tea Cup

Fish passes Rhinau and Marckolsheim (Rhine River) currently under construction

- Estimated costs: 80m Euro total
- FP design flow: max. 30 m<sup>3</sup>/s vs. ~1,500 m<sup>3</sup>/s of HPP (⇒ 2%)  
*comparison Iron Gate:*  
IG1 ⇒ 1.4%  
IG2 ⇒ 3.6%

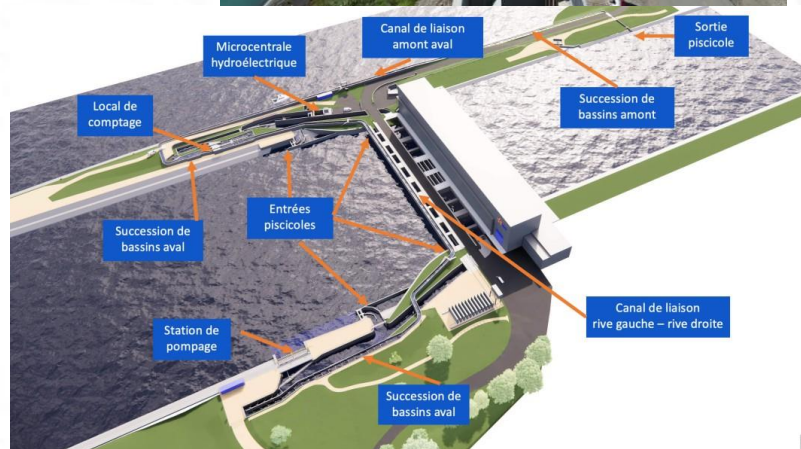


Illustration &  
photos of  
Rhinau fish pass  
(France)  
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## On the Finish Line ...

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- 3D hydraulic modelling of Romanian river side downstream of Iron Gate 2
- Preliminary design of 3 fish passes
- Roadmap for further project implementation  
incl. 1st rough cost estimate
- Final Report



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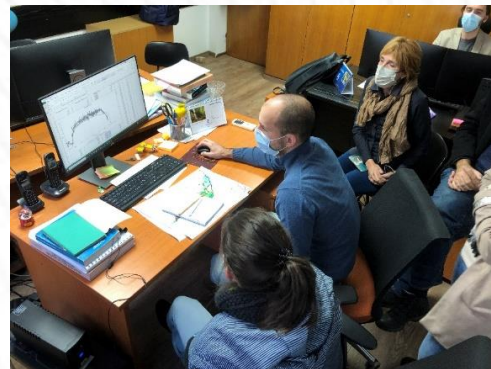
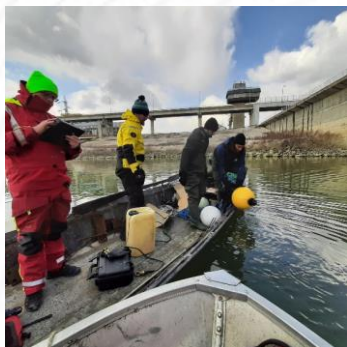
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## Thank you!



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